Super Fast-Track®

Residential Steel/Concrete Composite System

"New Generation of Modular Construction"

Construction

The erection of structural steelwork consists of the assembly of steel components into a frame on site. The processes involve lifting and placing components into position, then connecting them together. Generally this is achieved through bolting and no site welding is used in Super-Fast Track system.

The assembled frame needs to be aligned before bolting up is completed, and the structure handed over to the principal contractor.
Often the ability to complete these processes safely, quickly and economically is influenced significantly by early decisions made during design long before erection commences. It is important that designers clearly understand the impact that their decisions can have; "buildability" is a valid design objective.

Good site co-ordination will facilitate a smooth running project. Adequate access is required by the steelwork contractor for steel transportation, unloading and erection, both on the site as well as on surrounding or adjacent access roads. The provision of well prepared level ground that is able to take the requisite wheel loads is essential.

Planning for Construction

To achieve the client's aspirations on cost, programme and quality, planning for construction should start at the very beginning of the design process. Such planning should consider the construction sequence, the design factors that affect buildability, and site practice in terms of typical erection plant.

Construction sequence

A separate article on Health and Safety includes a section that identifies the design decisions that affect the erection method statement development. In the broader design and planning context, there are three planning factors that affect the buildability of the scheme. These are:

- Practical erection sequence. The location of bracing systems or other means of maintaining structural equilibrium are crucial here.
- Simplicity of assembly. Simply-assembled connections are the main factors here.
- Logical trade sequences.

Design factors

Four design factors to be considered that contribute to buildability are:

- Repetition and standardization. There are two aspects to standardization: repetition of the same building type and common / standard details for connections.

- Achievable tolerances. If "tight" tolerances are specified then special controls will be needed and possibly specially-engineered details.
- Frame type. Here, the primary choice is between braced frames or continuous frames
- Floor systems. For multi-storey frames, the choice of floor system will affect the erection sequence as it determines the stability of the part erected structure.

Steel erection

Steel erection essentially consists of four main tasks:

- Establishing that the foundations are suitable and safe for erection to commence.
- Lifting and placing components into position, generally using cranes.. To secure components in place bolted connections will be made, but will not yet be fully tightened. Bracings may similarly not be fully secured.
- Aligning the structure, principally by checking that column bases are lined and level and columns are plumb. Packing in beam-to-column connections may need to be changed to allow column plumb to be adjusted.
- Bolting-up which means completing all the bolted connections to secure and impart rigidity to the frame.

Erection techniques

Cranes and MEWPs (Mobile Elevating Work Platforms) are predominantly used for the erection of structural steelwork for buildings. Generally, cranes may be divided into two broad categories, mobile and non-mobile. The first category includes truck mounted cranes, crawler cranes and all-terrain cranes, whilst the second category primarily covers tower cranes.

MEWPs are used to access the steelwork during erection, i.e. to bolt-up the pieces being lifted in by the crane.

Mobile cranes

Normally, truck mounted cranes do not require a back-up crane for site assembly, and require very little set-up time. These two attributes mean that they are suitable for one-off, single day commissions.

Their main drawback is that to achieve a high lifting capacity from a light vehicle, a larger footprint is required than for an equivalent crawler crane. The size of the footprint can be increased using outriggers, but good ground conditions are necessary to provide a solid base and ensure adequate stability.

Crawler cranes are more rugged than truck mounted cranes. Ground conditions are therefore less critical. Crawler cranes may travel with suspended loads on site, because they are stable without the use of outriggers. They also have a relatively high lifting capacity. Daily hire is not possible for crawler cranes, because transportation to and from site is expensive, and they require site assembly. They are however more competitive than truck mounted cranes for long periods on site in a relatively fixed location.

All-terrain cranes provide a compromise between the advantages and disadvantages of crawler cranes and truck mounted cranes. They are about 20% more expensive to hire than the latter.
Typical mobile cranes, be they crawlers, truck mounted cranes, or all-terrain, have a rated capacity of around 30 t to 50 t. However, actual lifting capacity is a function of radius, and may be much less than the rated capacity for a given situation.

Site bolting

Site connections should generally be bolted, as it is faster, less susceptible to poor weather conditions, and has less onerous access and inspection requirements than site welding.
Structural bolting practice generally used in 2 mm clearance holes. The recommended option of M20 8.8 fully threaded bolts is readily available. Property class 4.6 bolts are generally used only for fixing lighter components such as purlins or sheeting rails, when 12 mm or 16 mm bolts may be adopted

Bolts are discussed in the SCI publication Design for Manufacture Guidelines (P150), from which the following points are taken:

- The use of different grade bolts of the same diameter on the same project should be avoided.
- Washers are not required for strength with non-preloaded bolts in normal clearance holes.
- When appropriate, bolts, nuts and washers should be supplied with a corrosion protection coating which does not require further protection on site.
- Bolt lengths should be rationalized.

Common practice is to specify fully threaded bolts, meaning one bolt size can be universally used for a large number of connections. The use of M20, 8.8 fully threaded bolts 60 mm long is recommended, as around 90% of simple connections could be made using such bolts.

Although there are potential minor extra manufacturing costs due to an increase in the average bolt length and a need for more threading, significant overall savings are possible when standard, fully threaded bolts are used:

- Reduced prices due to bulk purchasing
- 'Just in time' (JIT) purchasing
- No need to compile extensive bolt lists (giving details of bolt types and locations)
- Smaller stock
- Less handling due to reduced sorting
- Faster erection
- Reduced errors (therefore increased safety)
- Reduced wastage.

Installation of metal decking

Composite floors, comprising profiled steel decking and insitu concrete, are widely used in steel-framed multi-storey buildings. They have a proven record of providing an economic solution that can be erected quickly and safely.

The main advantage of using steel decking at the erection stage is that the decking can be used as unpropped permanent formwork when the supporting beams are at not more than 3 m to 3.5 m centers. For greater spans, propping, or a deck with a ‘deep’ profile, is needed. The designer should adopt a framing plan to reflect the fact that the decking is only one way spanning (using a regular grid, with orthogonal beams where possible).

The installation of metal decking and through deck stud welding

The sheets are laid out as erection progresses up the building. In this way the decking provides a working platform at each floor level, thereby eliminating the need for temporary platforms. It also serves as a crash deck to protect operatives working at lower levels from small objects, and it reduces the effective height at which erectors must work.

For speed of erection, the decking is normally secured to the beams using shot-fired pins. This positive attachment helps to maintain the stability of the steel frame during erection, and laterally restrain the top flanges of the beams during casting of the slab. At the ends of each sheet, the pins should be placed at 300 mm centers, but over intermediate beams the spacing can be increased to 600 mm. If the decking is required to act compositely with the beam, additional attachment is required. This is usually achieved by through-deck welding of the shear connectors.